

# Comparison of Dorsal Spines and Vertebrae as Ageing Structures for Little Tunny, *Euthynnus alletteratus*, from the Northeast Gulf of Mexico

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## ABSTRACT

The first dorsal spine (cross section) and 33rd caudal vertebra were used to estimate the age and growth of little tunny, *Euthynnus alletteratus*, from the northeast Gulf of Mexico. Spines from 234 fish (315 to 741 mm fork length) and vertebrae from 121 fish were collected off Panama City, Fla., in 1980 and 1981.

Ninety-six percent of the number of growth bands on cross sections of the first dorsal spine agreed with the number of ridge groups found on the vertebrae from the same fish. Mean sizes-at-age that were back-calculated from growth band measurements on vertebrae and spines were similar to the mean sizes-at-age estimated from spines of little tunny from Senegal, West Africa, but were less than the sizes-at-age for fish from other areas.

## INTRODUCTION

Little tunny, *Euthynnus alletteratus*, is a pelagic species that occurs throughout the tropical and subtropical Atlantic areas, including the Mediterranean Sea and the Gulf of Mexico. This species is a seasonal migrant in the Gulf of Mexico and is abundant off northwest Florida during the summer. No estimate is available of the size of the stock(s) in the Gulf of Mexico; however, the stock is considered to be quite large (Anonymous<sup>2</sup>).

No information is available on age and growth or on methods to obtain such estimates for little tunny in the Gulf of Mexico. Age estimates have been made for this species off Senegal, West Africa (Postel 1955; Cayré and Diouf 1980, 1983), Spain (Rodríguez-Roda 1979), and in the Mediterranean Sea (Landau 1965). These estimates were developed from growth marks on dorsal spines and on vertebrae and from the length-frequency distributions of the catch.

My objective in this paper was to compare the suitability of dorsal spines and vertebrae as age and growth determination structures for little tunny from the Gulf of Mexico.

## METHODS AND MATERIALS

Two hundred and thirty-four little tunny were collected from the commercial fishery off Panama City, Fla., in September and October 1980 and June 1981. The fish ranged in size from 315 to 741 mm fork length (FL). The first dorsal spine was removed and the fork length was measured. The caudal peduncle, which included the 33rd vertebra, was collected from 121 of the 234 fish.

Cross sections were prepared from the first dorsal spine by: 1) Sawing the first 3 mm of spine shaft above the condyle with a Dremel<sup>3</sup> tool, 2) placing the shaft section on a mounting tag

using Lakeside No. 70C thermoplastic cement and sectioning the shaft using the method described by Berry et al. (1977), 3) removing three 0.18 mm thick serial sections from the cement with 50% isopropanol, and 4) mounting the clean sections in 20% Piccolyte cement (20% Piccolyte, 80% xylene) on glass slides.

Spine cross-sections were examined and measured using closed-circuit television, which projected an image of the section onto a monitor screen at 40× magnification. Sections were viewed under transmitted light and measured with a ruler. Translucent (light) ring groups consisting of many fine concentric lines on the cross-sections were counted and their distances from the center of the spine measured following the description by Jolley (1977). These measurements (in millimeters) include the following: 1) Spine radius ( $R$ )—the maximum lateral distance at a 90° angle to the spine axis on the largest of the lobes from the estimated center of the spine, and 2) spine radii ( $B$ )—the distance from the estimated center of the spine to the distal edge of each incremental growth mark or band (Fig. 1). Each radius was assumed to represent a year-mark.

The vertebrae of the caudal peduncle of each fish were removed and stained using the alizarin red S process of Berry et al. (1977). The 33rd vertebra was examined for growth cycles. This vertebra was selected because its unique shape facilitated its identification and was used by Landau (1965) in her study of little tunny from the Mediterranean Sea.

The vertebrae were cut in half through the dorsal-ventral plane to expose growth marks which appeared as stained ridges on the centrum surface. Ridges on the anterior centrum were counted and measured on the left lateral surface. The counts and measurements were made with an ocular micrometer in a binocular dissecting microscope at 6× magnification. Measurements were as follows: 1) Vertebral cone depth ( $V$ )—the distance from the cone focus to the anterior cone edge, and 2) the centrum ridge radii ( $v$ )—the distance from the cone focus to the distal edge of each couplet of cone ridges which constituted a presumed year-mark (Fig. 2).

The relationships between  $R$  and FL and between  $V$  and FL were determined with least square regressions and the degree of significance set at  $\alpha = 0.05$ . These relationships were used

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<sup>3</sup>Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

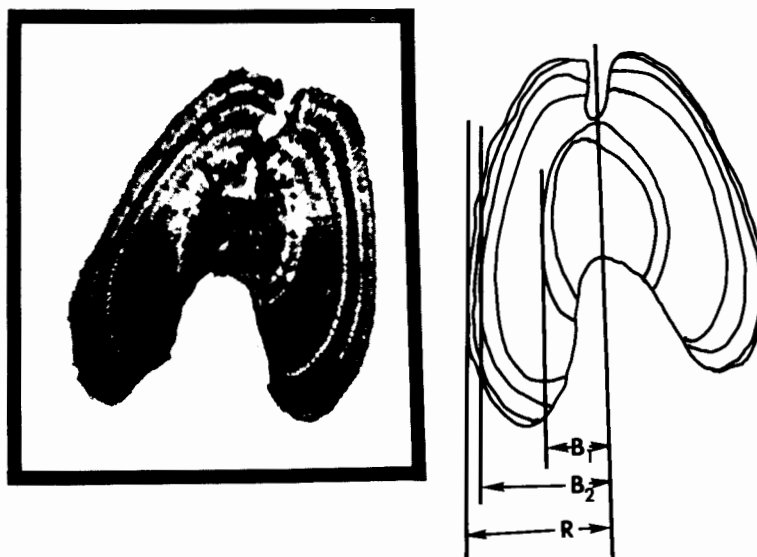


Figure 1.—Cross section of first dorsal spine of a 550 mm FL little tunny collected 2 June 1981 off Panama City, Fla.  $R$  is spine radius and  $B_1$  and  $B_2$  are measurements from the center of the spine to the distal edges of spine bands 1 and 2, respectively.

to back calculate the size at band and ridge couplet formations (ages) using methods adapted from Tesch (1971), Ricker (1975), and Everhart et al. (1975).

## RESULTS AND DISCUSSION

The first dorsal spine of little tunny is bilobed with a vascularized core or internal matrix (Fig. 1). This core appears to become larger as the fish grows and in older fish may obscure early growth marks (i.e., those close to the spine center).

The appearance of the spine cross sections was similar to that described by Cayré and Diouf (1980, 1983) for little tunny from Senegal. Growth marks (translucent rings) were very evident in the cross sections. Cayré and Diouf (1983) reported that these rings were formed in pairs on a yearly basis and re-

ferred to them as doublets. The marks on spines in my collection also appeared to be formed in pairs; however, the space between members of a band (doublets) varied and, in some cases, the band appeared to be a wide, single, translucent ring. These wide, single, translucent rings were also counted as year-marks.

A significant relationship that was found between FL and spine radius ( $R$ ) was expressed best by a power function whose coefficient of correlation ( $r$ ) was 0.932 (Fig. 3). This equation was  $FL = 32.42(R^{0.7135})$ .

The back-calculated mean lengths at band formation (estimated ages) were less than parallel to the empirical mean lengths (mean lengths-at-capture), which was expected considering that some growth had occurred between time of band formation and capture (Table 1, Fig. 4).

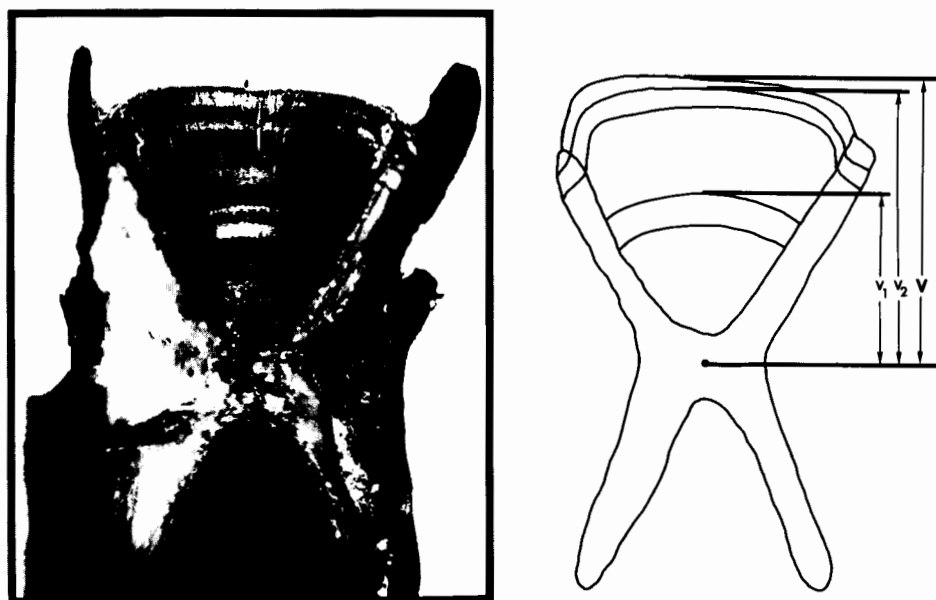


Figure 2.—Vertebral centrum from a 550 mm FL little tunny collected 2 June 1981 off Panama City, Fla.  $V$  is vertebral cone radius and  $v_1$  and  $v_2$  are measurements from the vertebra's center to the distal edge of vertebral ridge couplets 1 and 2, respectively.

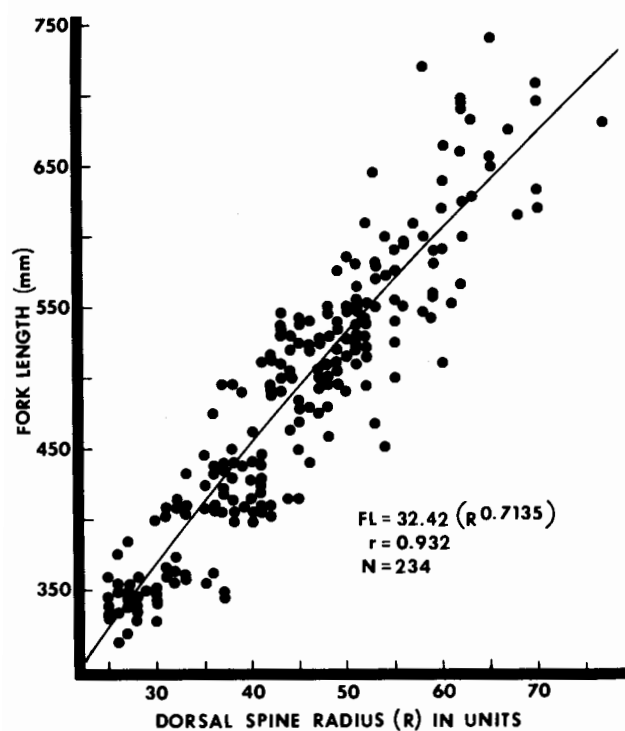


Figure 3.—Relationship between dorsal spine radius and fork length of little tunny from northwest Florida.

The growth marks in the vertebrae of little tunny are in the form of ridges. The centra of little tunny in the Gulf of Mexico have the same appearance as the centra of little tunny in the Mediterranean Sea described by Landau (1965). The ridges of the centra appear to be formed in pairs or couplets.

A significant relationship was found between FL and vertebral cone radius ( $V$ ) and was described best by the power function  $FL = 44.68(V^{0.6145})$  with  $r = 0.863$  (Fig. 5). The back-calculated mean lengths at ridge formation and their corresponding mean back-calculated lengths based on spine band measurements were less than the mean empirical lengths (Table 2, Fig. 6). However, the mean lengths based on spines were consistently longer than their respective mean lengths based on vertebrae, which could indicate that the vertebral ridge couplet formation

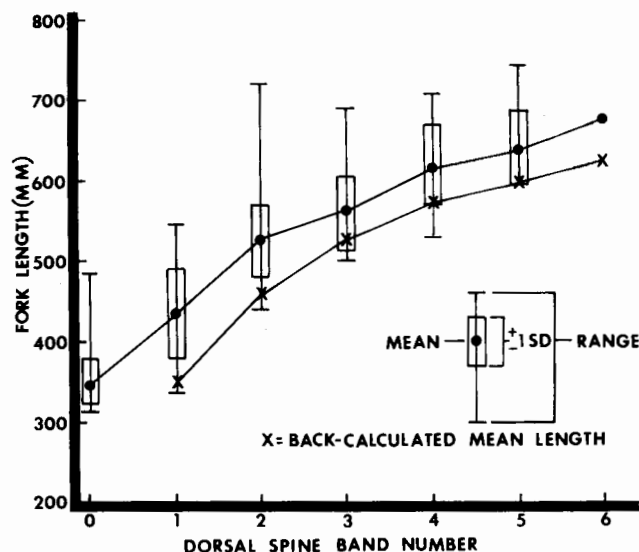


Figure 4.—Length at capture and back-calculated length at spine band formation for little tunny from northwest Florida.

is completed before the spine band completion. These differences may be the result of differential response of the structures to mineralization (i.e., calcium metabolism) such as was reviewed by Simkiss (1974). One cannot, however, rule out the possibility that the differences are artifacts that are the result of small sample sizes.

An agreement of 96% (3 vertebrae and 2 spines of the 121 pairs were unreadable) was obtained between the estimated age of fish determined by spine bands and the estimated age determined by vertebral ridge couplets. Therefore, both structures appeared to be useful as age and growth estimators for little tunny from the northeast Gulf of Mexico; however, vertebrae seemed to estimate smaller sizes at age than spines.

Other investigators have reported the use of spines and vertebrae to estimate the age of little tunny. Spines were reported by Cayré and Diouf (1980, 1983) as useful structures for age determination of fish from the west coast of Africa, and Rodríguez-Roda (1979) reported their usefulness in ageing little tunny off the Atlantic coast of Spain. I have summarized their information, along with Postel's (1955) age information,

Table 1.—Mean back-calculated fork lengths (mm) at spine band formation for little tunny from northwest Florida.

| Band class       | Number of fish | Mean length-at-capture (mm) | Mean back-calculated fork length for each band number |        |        |        |        |        |
|------------------|----------------|-----------------------------|---|--------|--------|--------|--------|--------|
|                  |                |                             | 1   | 2      | 3      | 4      | 5      | 6      |
| 1                | 99             | 437.62                      | 347.31  |        |        |        |        |        |
| 2                | 45             | 523.36                      | 352.56  | 458.07 |        |        |        |        |
| 3                | 31             | 560.90                      | 367.69  | 466.94 | 532.35 |        |        |        |
| 4                | 18             | 612.78                      | 345.44  | 471.22 | 533.69 | 577.05 |        |        |
| 5                | 7              | 639.71                      | 333.17  | 450.61 | 511.90 | 557.36 | 602.01 |        |
| 6                | 1              | 675.00                      | 294.99  | 380.47 | 467.16 | 524.13 | 578.71 | 623.89 |
| Weighted mean    |                |                             | 350.71  | 461.81 | 529.71 | 560.71 | 599.09 | 623.89 |
| N                |                |                             | 201   | 102    | 57     | 26     | 8      | 1      |
| Growth increment |                |                             | 350.71  | 111.10 | 67.90  | 40.00  | 29.38  | 24.80  |

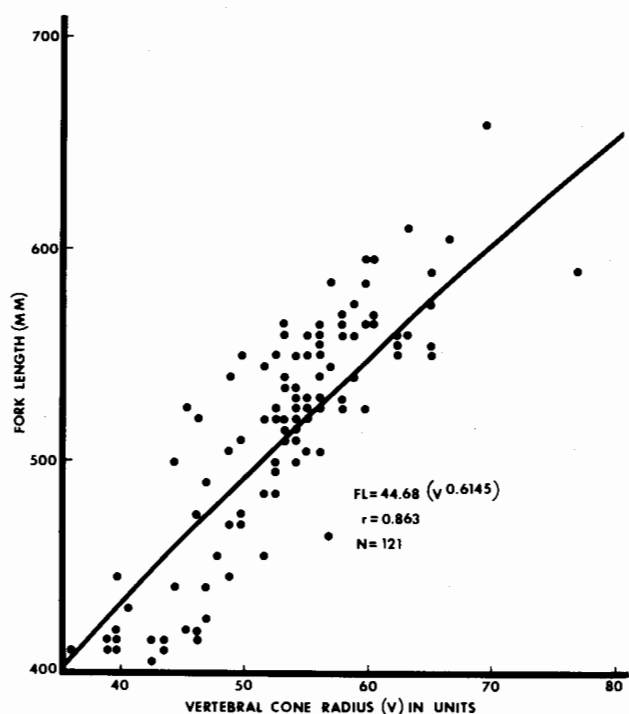


Figure 5.—Relationship between vertebral cone radius and fork length of little tunny from northwest Florida.

developed from length-frequency distributions from Senegal (Fig. 7).

A wide range of back-calculated body sizes at various ages is evident from a comparison between the studies. The mean sizes-at-age for little tunny from the northeast Gulf of Mexico are similar to those reported by Cayré and Diouf (1980, 1983) for fish from Senegal, but they are less than the sizes-at-age reported for fish collected by other investigators.

The differences in the mean sizes at age of the various reports may be the result of differences in racial characteristics or har-

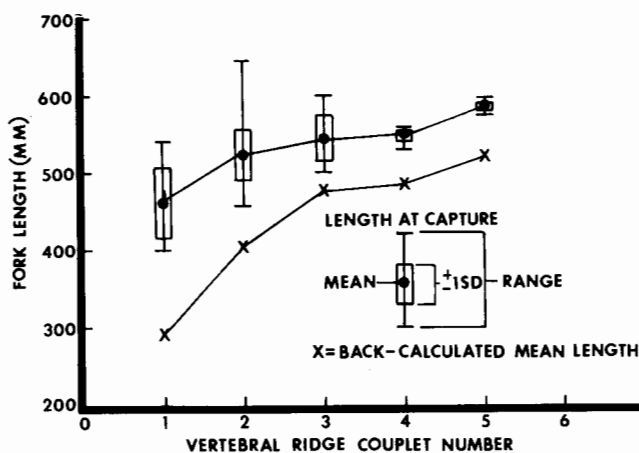


Figure 6.—Length at capture and back-calculated lengths at growth increment count formation and corresponding spine band formation for little tunny from northwest Florida.

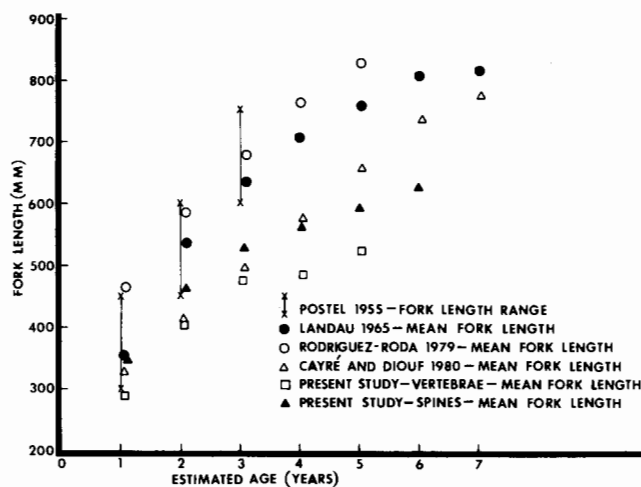


Figure 7.—Summary of age-length information on little tunny.

Table 2.—Mean back-calculated fork lengths (mm) at vertebral ridge group formation (corresponding values calculated from dorsal spine measurements in parentheses) for little tunny from northwest Florida.

| Ridge group class | Number of fish | Mean length-at-capture (mm) | Mean back-calculated fork lengths for each ridge group |                    |                    |                    |                    |
|-------------------|----------------|-----------------------------|--|--------------------|--------------------|--------------------|--------------------|
|                   |                |                             | 1  | 2                  | 3                  | 4                  | 5                  |
| 1                 | 47             | 461.98                      | 335.94<br>(378.07)                                     |                    |                    |                    |                    |
| 2                 | 40             | 522.78                      | 273.30<br>(360.78)                                     | 432.12<br>(470.78) |                    |                    |                    |
| 3                 | 24             | 546.00                      | 246.05<br>(348.37)                                     | 372.22<br>(441.73) | 483.10<br>(503.56) |                    |                    |
| 4                 | 3              | 550.67                      | 247.50<br>(320.99)                                     | 328.32<br>(395.30) | 463.80<br>(442.51) | 498.35<br>(492.42) |                    |
| 5                 | 2              | 587.50                      | 205.05<br>(340.35)                                     | 348.50<br>(429.64) | 422.44<br>(488.78) | 461.45<br>(533.59) | 520.20<br>(584.87) |
| Weighted mean     |                |                             | 291.20<br>(364.09)                                     | 404.35<br>(456.20) | 476.92<br>(496.22) | 483.59<br>(508.89) | 520.20<br>(584.87) |
| N                 |                |                             | 116  | 69                 | 29                 | 5                  | 2                  |
| Growth increment  |                |                             | 291.20<br>(364.09)                                     | 113.15<br>( 92.11) | 72.57<br>( 40.02)  | 6.67<br>( 12.67)   | 36.61<br>( 75.89)  |

vesting techniques. These factors, which influence our perception of stock conditions of little tunny, have been summarized by Yoshida (1979). The present study and that of Cayfe and Diouf (1980) had few fish older than 4 yr of age and thus probably do not accurately reflect the mean sizes-at-age for older fish in their respective geographic locations.

The generally accepted criteria for validation of a fish's hardpart for age determination and back calculation of size at previous ages are as follows: 1) The hardpart must be constant in number and identity throughout the life of the fish, 2) the hardpart must grow proportional to the growth of the fish, 3) the hardpart must have a recognizable pattern of growth marks, and 4) the hardpart pattern must be such that a regular time scale can be allocated to the pattern (Williams and Bedford 1974; Everhart et al. 1975; Brothers 1983; Smith 1983). The first dorsal spine and 33rd vertebra of little tunny both fit most of the criteria for acceptable age determination and back-calculation structures for this species in the Gulf of Mexico.

The first dorsal spine and 33rd vertebra are unique structures and are easily identified. Both structures have good correlations to fork length ( $r = 0.932$  for spines and  $r = 0.863$  for vertebrae). Their respective growth patterns (bands on spines and ridge couplets on vertebrae) are formed in a recognizable pattern and agree with each other in number. The final criterion of known mark formation periodicity has not been determined.

Further investigation is needed in the northeast Gulf of Mexico on the age and growth of little tunny, especially to determine the time and cause of mark formation (bands on the dorsal spine and ridges on vertebrae).

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